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TRANSLATIONS 1

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INTERNATIONAL CENTER FOR LIVING AQUATIC RESOURCES MANAGEMENT

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Hanging Culture of the Green Mussel (*Mytilus smaragdinus* Chemnitz) in Thailand

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Abstract

Manila rope was used for the hanging method of green mussel (*Mytilus smaragdinus* Chemnitz) culture. The experiment was conducted at Bang pakong District, Chachoengsao Province, from November 1977 to August 1978. The monthly density of spat on rope, their rate of growth and environmental factors in the experimental area were determined.

Mussels reached marketable size, 5.5-6.0 cm, in 8 months. The rope began to disintegrate during the period. More durable materials are required for this form of culture.

Introduction

At the present time, green mussel culture is performed using wood stakes such as kapor[1] or bamboo stakes. The stakes are set out in the sea near the shore to attract spat. A large amount of wood is used for each spat fall and the stakes last only 1 to 2 years. Wooden stakes are becoming scarce and costly. The development of green mussel culture using other materials and new methods which can increase yields at low cost, will enable culturists to continue successfully in their business. This should encourage significant expansion of the industry.

Mussel culture by the hanging method was first conducted successfully in Spain. Later, the method was introduced into other countries in Northern Europe. Antheprachа (1964) reported that there were two types of hanging method for mussel culture, namely bunching and sacking. Banchong (1977) classified green mussel (*Mytilus smaragdinus*) culture into three methods, staking, culturing on the surface of the sea, and hanging.

Tortell et al. (1978) found that green mussels spawned throughout the year, with peaks in March-April and November-December. Hrs Brenko (1973) reported that *Mytilus galloprovincialis* larvae settled at about 250 microns in length after a pelagic life of about 7-10 days.

In an experiment for suitable cultch materials for *Mytilus galloprovincialis*, Dare and Davies (1975) found that one meter lengths of rope, made from coconut fiber, attracted 3,000 to 7,000 *Mytilus galloprovincialis* spat per week. Later, Tortell (1976) reported that carbon blacked polypropylene rope attracted more *Mytilus galloprovincialis* than coconut fiber, sisal rope and other colored polypropylene ropes. It also attracted fewer barnacles and other burrowers.

Pairoj (1970) reported that the maximum number of green mussel spat along the coast of Chon Buri Province occurred in October and November. After seven months of culture, mussels grew from spat to a mean length of 5.86 cm, but mortality during this period was over 95%. Tan (1975) found that green mussel spat settled at depths of 1.5 to 11.7 m below the spring high water level. The maximum

[1] Kapor: a native name of mangrove palm date

density was found at 2.4 to 4.5 m. Survival rate was highest between 2.4 and 3.9 m equivalent to 0.12% exposure. Sivalingam (1977) found that the most suitable salinity, temperature and pH were 27 to 35 ppt; 26 to 32°C and 6.0 to 8.2 respectively. He also observed that the main food of green mussel was the diatom (*Coscinodiscus nodulifer* Schmidt).

The objectives of the present study were to study new techniques for hanging culture of green mussel using ropes, to evaluate the attractiveness of ropes to green mussel spat, to study the mussel growth rate and to investigate the environmental factors in the culture area.

Materials and Methods

The study was conducted at Bang pakong district, Chachoengsao Province, where green mussel culture by the wood staking method is presently carried out. The study area was 7.5 m^2, using 12 poles staked at 3 m intervals. Ropes were used to connect the poles and were suspended about 2 m above the sea bed. Hanging ropes, of 25 mm diameter Manila rope 2 m long, were then fastened to the horizontal ropes at 0.5 m intervals. The bottom end of each hanging rope was tied to a cement block weighing about 4-6 kg to prevent the rope from swinging in heavy wind or strong tides. The apparatus is shown in Fig. 1.

Five hanging ropes, taken randomly, were collected monthly. The number of mussels adhering to each rope was counted, and the average number per rope calculated. On the basis of these data, the monthly average mortality per rope was also determined.

Between 50 and 100 mussels were picked at random from the hanging ropes each month. Shell length and width, total weight, shell weight and wet and dry meat weight (dried at 70°C for 48 hours) were determined for each mussel.

From the above information, the following parameters were determined:

- proportion of wet and dry meat weight and shell weight in total weight,
- time at which green mussels attain best condition,
- length-weight relationship using the formula

$$W = aL^b \text{ (or } \log W = \log a + b \log L)$$

where W = total weight and L = length of the shell.

The study included examination of environmental conditions, such as temperature, depth, salinity, conductivity, suspended solids, pH and dissolved oxygen (DO) at various depths. Samples of plankton in the area were collected by oblique hauls using a phytoplankton net for qualitative and quantitative analysis.

Results

Ropes were hung out on 14 October 1977. Spat began to attach to the ropes in November but were more obvious and most dense by December. The spat clustered along the whole length of the ropes.

DENSITY OF MUSSELS ON THE ROPES

In January 1978, when the spat were 2 months old, the average number attached per meter of rope was 849. This number decreased until the end of the experiment in July 1978, when the mussels were 8 months old and their density was 359/m. The ropes had deteriorated completely by August. It was also found that the mortality rate of mussels on the hanging ropes was highest in February and July 1978, being 20.35% and 26.81% respectively. The lowest rate of 2.49% was found in April. Density of spat and mortality rates are presented in Table 1.

GROWTH

The changes in average size and weight over the 6 month period from January to July were as follows: length increased from 2.14 to 5.70 cm, width 1.11 to 2.45 cm, total weight 0.53 to 8.49 g, shell weight 0.27 to 4.30 g, wet meat weight 0.26 to 4.19 g and dry meat weight 0.05 to 0.57 g.

The percentage increase in these parameters in the first month, January, was high: length 37.38%, width 30.63%, total weight 220.75%, shell weight 251.85%, wet meat weight 188.46% and dry meat weight 120.00%. However, the percentage rates of increase then decreased during March and April, increased slightly in May, and then decreased thereafter. The rate of increase in the last month (July) was: length 5.36%, width 4.26%, total weight 13.65%, shell weight 9.97%, wet meat weight 17.70% and dry meat weight 3.64%. Details are presented in Table 2 and Figures 2-5.

The average proportions of shell weight, wet meat weight and dry meat weight as percentages of total weight, were 50.94%, 49.06% and 9.43% respectively. In April, the proportion of shell weight had a maximum value of 63.48% while that of wet meat weight had a minimum value of 36.52% (5.04% dry weight). At the end of the experiment, the proportion of wet and dry meat weights in total weight were 49.35% and 6.71% respectively. The details are given in Table 3.

The length weight relationship was expressed by the equation:

$$W = 0.070671^{2.78478}$$

$$\text{or } \log W = 1.15075 + 2.78478 \log L$$

ENVIRONMENTAL FACTORS IN THE CULTURE AREA

Throughout the experimental period, environmental conditions in the study area did not vary greatly. The ranges of the parameters measured were: depth, 2.0 to 4.0 m; air temperature, 29.0 to 34.8°C,; seawater temperature, 28.0 to 33.3°C; pH, 7.4 to 8.3, DO, 5.5-7.0 ppm; suspended solids, 4.0-15.0 ppm. Salinity and conductivity during the period January to May ranged between 25.0 to 31.0 ppt and 46.6 to 52.1 micromho/cm respectively. After May, these values decreased due to fresh water runoff. At the end of the experiment in July, conductivity had decreased to 15 micromho/cm; salinity in August was only 0.5 ppt. The details are presented in Table 4 and Figure 7.

Plankton density in the study area had peaks during 3 periods: February, 2,096,000 phyto plankters plus 272,000 zooplankters/m^3, May, 5,227,000 plus 916,000/m^3 and July, 691,000 plus 1,671,000/m^3. Details are shown in Figure 6.

Discussion

The green mussels reached market size 8 months after attachment, when the average wet meat content was 4.9 g or 49.4% of total weight. Plankton was most abundant during April and May and the growth rate and condition of the mussels were highest during this period.

After May 1978, the mortality rate gradually increased unt the end of the experiment. This was probably due to the decrease in salinity and deterioration of the rope.

The results demonstrated that the hanging method can be used in Thailand but that Manila rope was not a suitable material. In future experiments, cheap durable materials which attract more spat should be used and the results compared with the staking method. Rearing mussels in bags in deeper areas, using spat transplanted from over-crowded ropes, should also be investigated so that the advantages of the method can be assessed and made known for the benefit of the mussel farmers.

Acknowledgments

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Special thanks are also expressed to Ms. Arunee Jindanon and Ms. Sabaitip Sattayanakul for plankton analyses, Dr. Anan Saraya for his assistance in writing the English abstract and Ms. Lila Ruangpan for proof-reading and suggestions in preparing the report.

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Table 1. Density of mussel spat on rope during the experimental period.

Month	Age (Months)	Number of mussel spat/1 m 1	2	3	4	5	Average	Decrease No.	%	Remarks
November 1977	–	spat begin to settle on rope						–	–	
December	1	No data						–	–	
January 1978	2	820	845	946	735	900	849.2	–	–	
February	3	812	605	765	600	600	674.4	172.8	20.35	
March	4	500	740	675	700	560	635.0	41.4	6.12	
April	5	660	336	740	700	660	619.2	15.8	2.49	8 ropes were spoiled
May	6	315	600	700	610	580	561.0	58.2	9.40	12 ropes were spoiled
June	7	410	275	600	634	535	490.8	70.2	12.51	
July	8	258	328	347	343	520	359.2	131.6	26.81	ropes begun to deteriorate
August	9	ropes were completely deteriorated						359.2	100.0	

Table 2. Growth parameters of green mussel on experimental ropes from January to July 1978.

Month	Age (Months)	Shell length Average (cm)	length increase (cm)	%	Shell width Average (cm)	width increase (cm)	%	Total weight Average (cm)	increase (cm)	%	Shell weight Average (cm)	increase (cm)	%	Meat weight Average (cm)	increase (cm)	%	Dry meat weight Average (cm)	increase (cm)	%
1978																			
January	2	2.14	–	–	1.11	–	–	0.53	–	–	0.27	–	–	0.26	–	–	0.05	–	–
February	3	2.94	0.80	37.38	1.45	0.34	30.63	1.70	1.17	220.75	0.95	0.68	251.85	0.75	0.49	188.46	0.11	0.06	120.00
March	4	3.78	0.84	28.57	1.78	0.33	22.76	2.74	1.04	61.18	1.63	0.68	71.58	1.11	0.36	48.00	0.13	0.02	18.18
April	5	4.34	0.56	14.81	1.95	0.17	9.55	3.97	1.23	44.89	2.52	0.89	54.60	1.45	0.34	30.63	0.20	0.07	53.85
May	6	4.84	0.50	11.52	2.24	0.29	14.87	6.51	2.54	63.98	3.86	1.34	53.17	2.65	1.20	82.76	0.35	0.15	75.00
June	7	5.41	0.57	11.78	2.35	0.11	4.91	7.47	0.96	14.75	3.91	0.05	1.30	3.56	0.91	34.34	0.55	0.20	57.14
July	8	5.70	0.29	5.36	2.45	0.10	4.26	8.49	1.02	13.65	4.30	0.39	9.97	4.19	0.63	17.70	0.57	10.02	3.64

Table 3. Ratio between shell weight, wet meat weight and dry meat weight to total weight of green mussels from January to July 1978.

Monthly	Shell weight (%)	Wet meat weight (%)	Dry meat weight (%)
1978			
January	50.94	49.06	9.43
February	55.88	44.12	6.47
March	59.49	40.51	4.74
April	63.48	36.52	5.04
May	59.29	40.71	5.38
June	52.34	47.66	7.36
July	50.65	49.35	6.71

Table 4. Sea water quality at the experimental area during January-August 1978.

Month	Depth (m)	Air Temperature (°C)	Water Temperature (°C)	Salinity (ppt)	pH	DO (ppm)	Conductivity (mv/cm)	Turbidity (ppm)
1978								
January	4.0	31.0	28.2	31.0	8.3	6.0	50.5	5.0
February	3.0	31.3	29.6	32.3	7.7	7.0	50.9	4.0
March	3.0	31.0	29.0	28.0	8.2	6.0	41.3	8.0
April	3.0	32.6	32.3	28.0	8.1	6.0	52.1	7.5
May	2.0	34.8	33.3	25.0	8.3	6.0	46.6	10.0
June	3.0	33.1	31.3	18.0	7.6	6.2	25.7	7.0
July	4.0	33.0	32.7	7.8	8.2	5.5	15.0	4.0
August	2.0	29.0	28.0	0.5	7.4	--		15.0

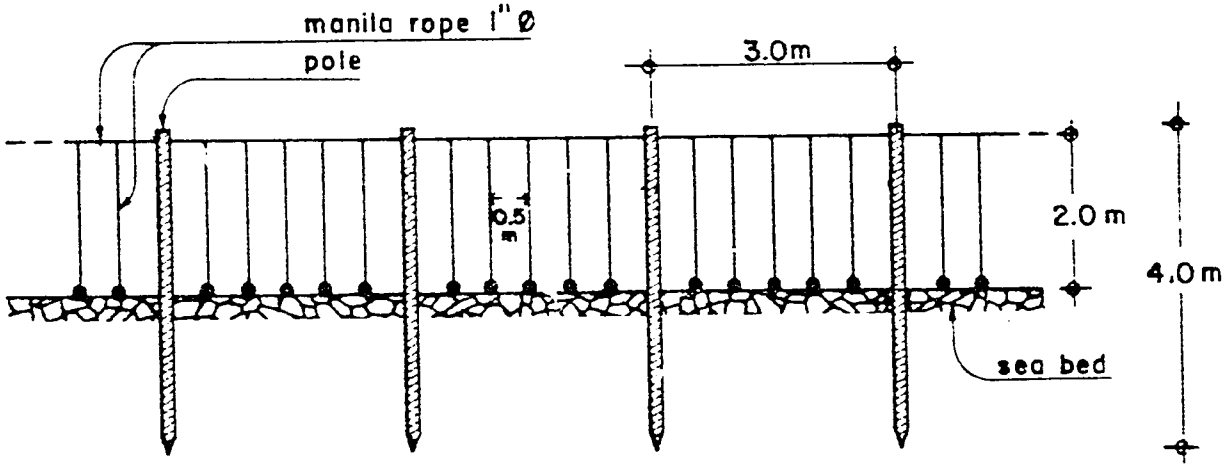

Fig. 1. Layout of the experimental culture method.

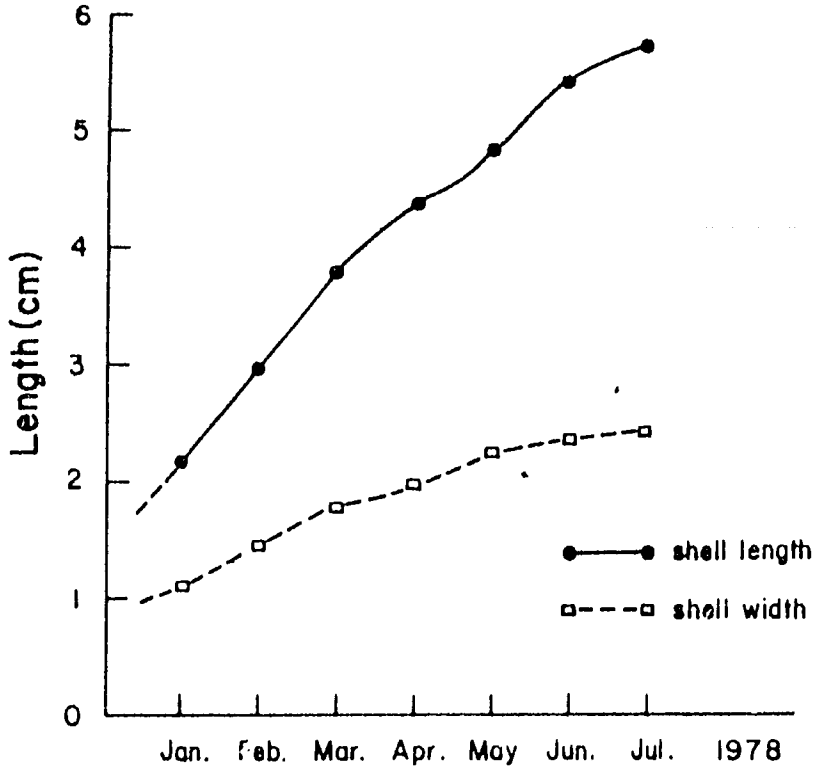

Fig. 2. Growth of green mussels, January-July 1978.

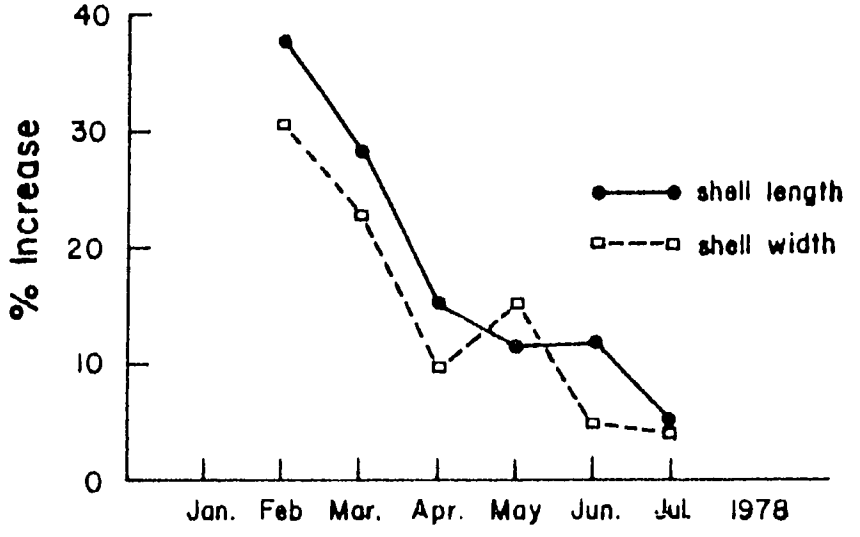

Fig. 3. Percent increase by month of shell length and width of green mussels.

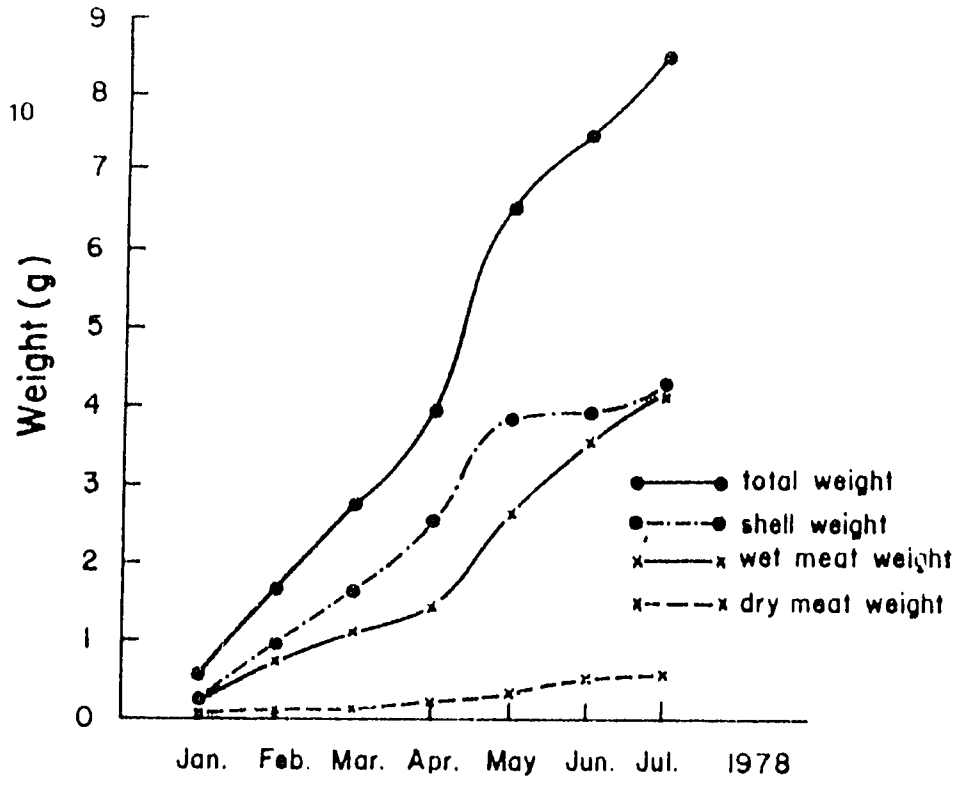

Fig. 4. Growth in weight of green mussels, January-July, 1978.

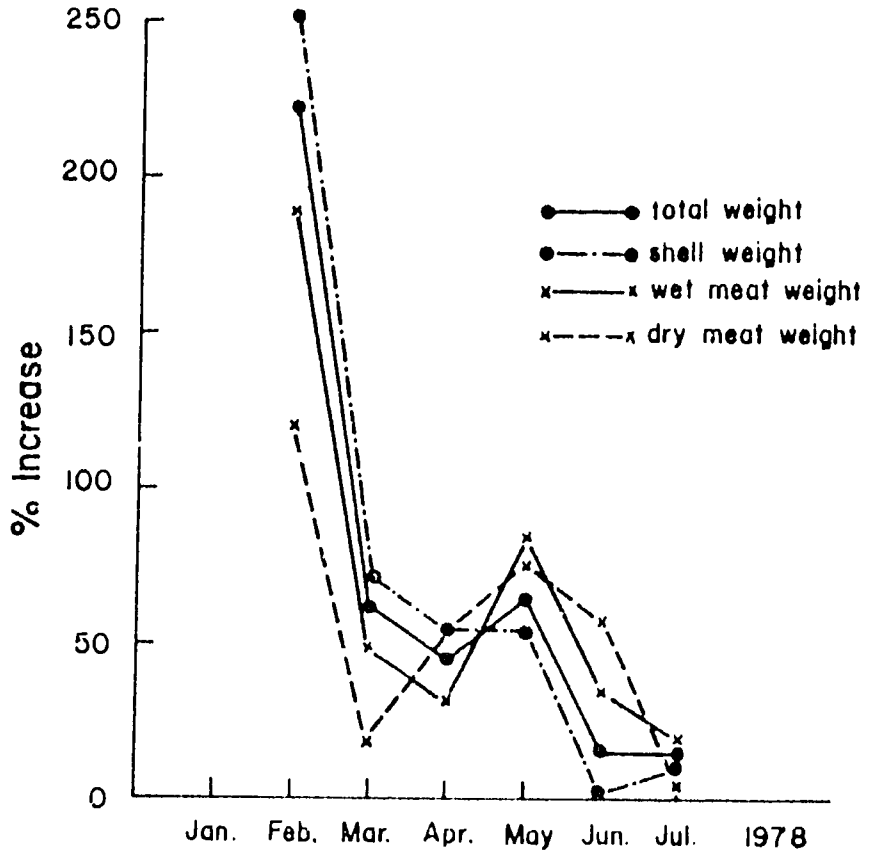

Fig. 5. Increase of weight of green mussels, January-July, 1978.

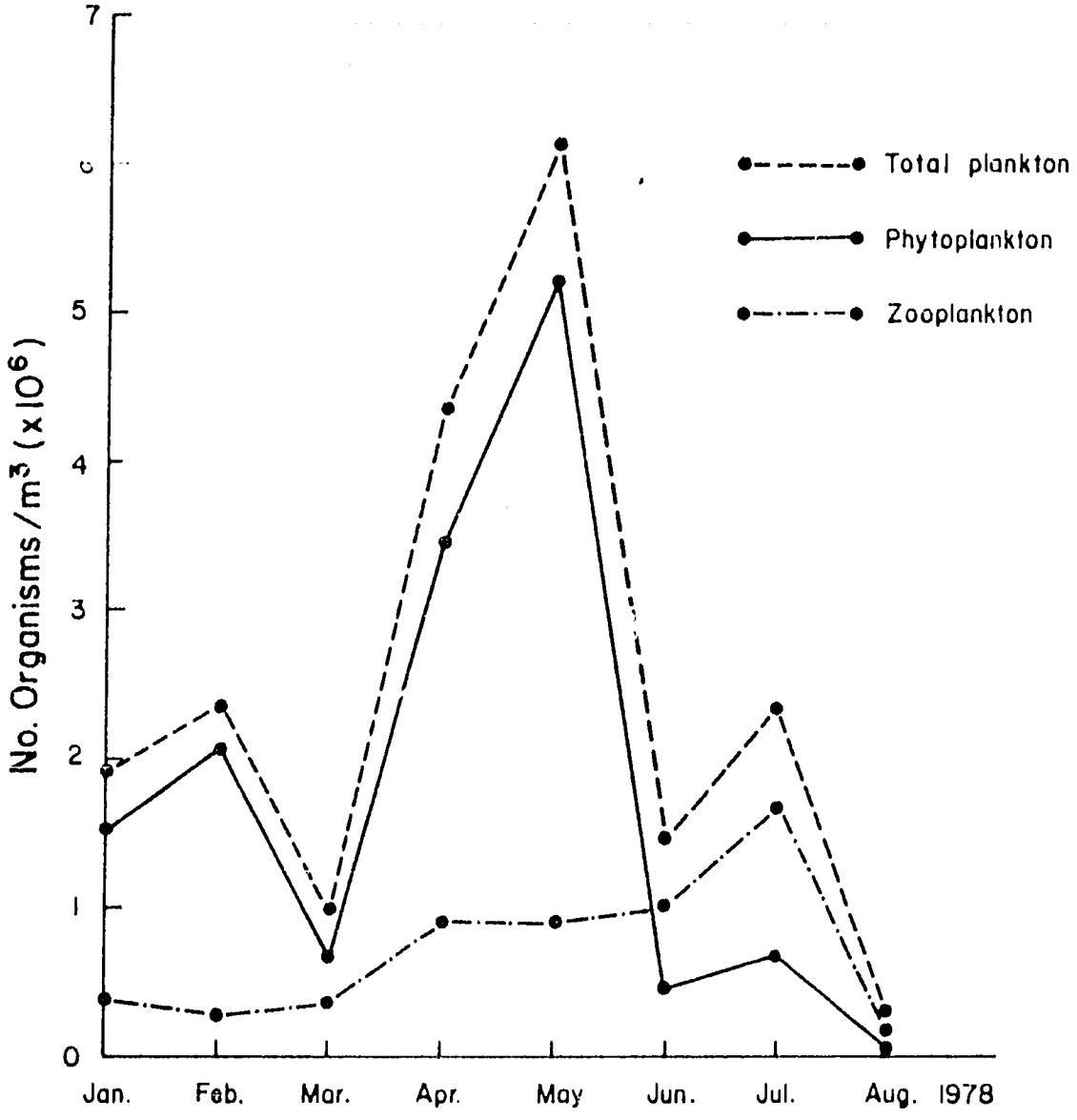

Fig. 6. Abundance of plankton in the experimental area, January-August, 1978.

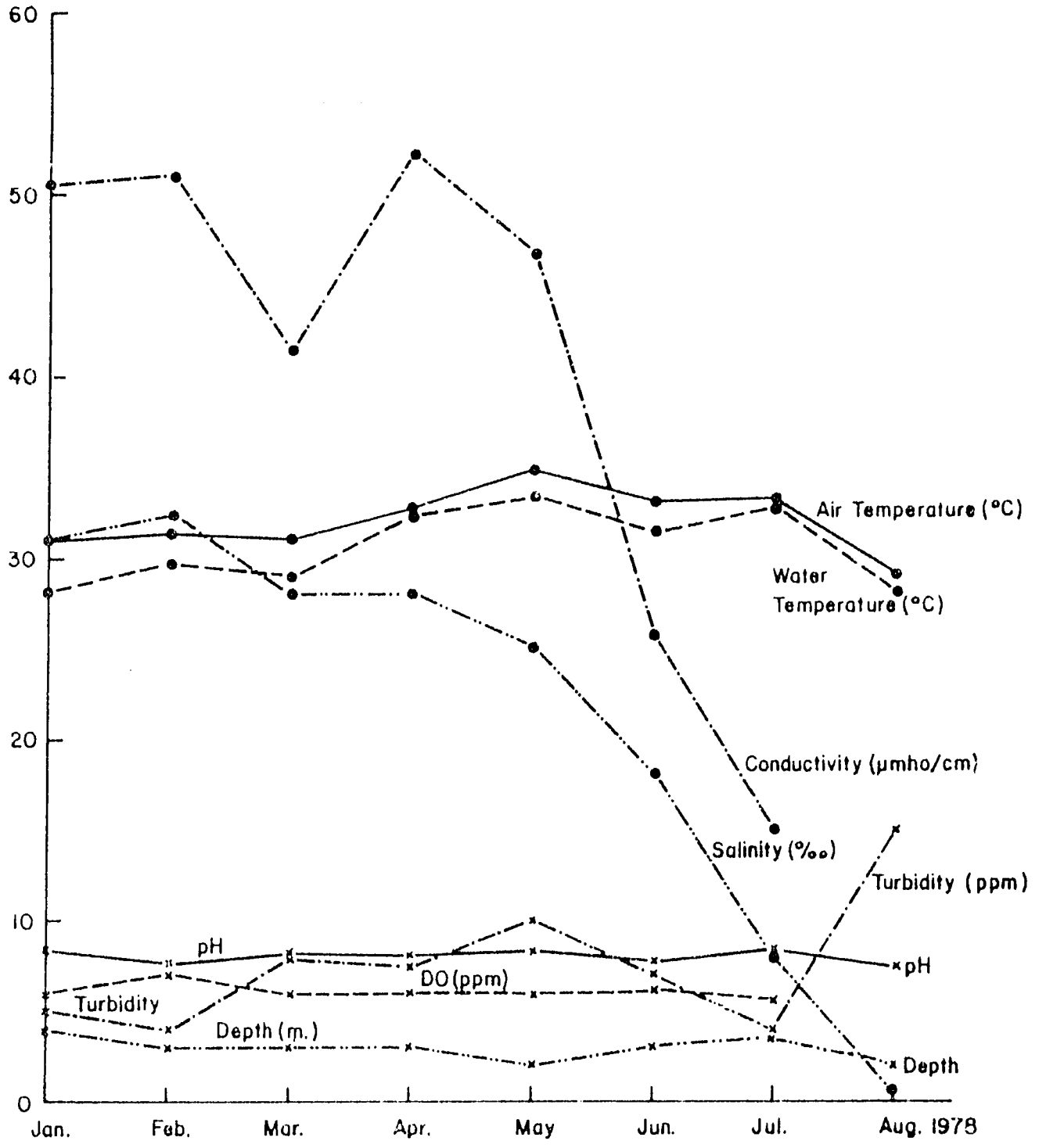

Fig. 7. Seawater quality in the experimental area, January August 1978.